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IoT-Driven Accident Alert and Rescue Management System for Smart Mobility

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Abstract

An IoT-enabled vehicle accident detection and rescue system is a modern approach aimed at improving road safety by identifying collisions as they occur and facilitating quick emergency assistance. Traffic accidents remain a major cause of death across the globe, and the lack of timely medical help frequently intensifies the severity of injuries. This system leverages the power of the Internet of Things (IoT) to monitor a vehicle's dynamics and detect accidents as they occur. It utilizes sensors such as accelerometers and gyroscopes to identify sudden changes in velocity or orientation that indicate a collision. A microcontroller, such as an Arduino or Raspberry Pi, processes the sensor data to determine whether an accident has occurred. Once an accident is detected, the system immediately turns on the global positioning system (GPS) module to determine the vehicle's exact location and uses the GSM module to send an emergency text message to preset contacts or nearby rescue teams. This alert includes critical information such as the accident time and precise location coordinates, allowing for immediate action. Additionally, the system can be integrated with IoT cloud platforms for real-time data logging and remote monitoring, which can be useful for traffic authorities or insurance companies. To avoid false alarms, the system can be programmed to allow manual cancellation of alerts by the driver within a short window. With optional enhancements like live camera feeds, mobile app integration, and machine learning-based accident verification, the system can become even more robust and intelligent. Overall, the IoT-based accident detection and rescue system provides a cost-effective, scalable, and life-saving solution that addresses one of the most critical challenges in modern transportation, offering timely assistance and reducing the loss of life due to delayed emergency response.

Keywords: Microcontroller, Internet of Things (IoT), global positioning system (GPS), global system for mobile communications (GSM), vehicle

INTRODUCTION

The rapid increase in road accidents has highlighted the urgent need for advanced technologies that can enhance vehicle safety and improve emergency response. An IoT-based vehicle accident detection and rescue system is a smart solution designed to address this issue by leveraging the power of IoT. The system utilizes sensors, such as accelerometers and global positioning system (GPS) modules, to continuously monitor a vehicle's movement and detect any sudden impacts or abnormal patterns that may indicate an accident. Once an accident is detected, the system immediately sends an alert containing the real-time location and event details to emergency services, family members, or concerned authorities via GSM or cloud-based communication. This ensures a quick response and assistance, even if the victim is unconscious or unable to make a call. By automating accident

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reporting and integrating communication technologies, the system significantly reduces emergency response time, ultimately saving lives and improving overall road safety in a smart and efficient way.

PROPOSED METHODOLOGY

The proposed IoT-based vehicle accident detection and rescue system uses sensors such as accelerometers, gyroscopes, and vibration detectors to monitor real-time vehicle motion and detect sudden impacts. A microcontroller processes this data and retrieves the vehicle's GPS coordinates if an accident is detected. Using GSM or Wi-Fi modules, the system sends automated alerts with location and time details to redundant emergency communication channels. Optional cloud integration and mobile applications enable real-time tracking of contacts and rescue services. To ensure reliability, it includes backup power, manual override, and data storage, which enhance emergency response and increase the chances of timely medical assistance.

WORKING PRINCIPLE

The IoT-based vehicle accident detection and rescue system is a modern technological solution designed to detect road accidents in real time and immediately notify emergency responders to minimize the delay in medical assistance and potentially save lives. The system typically integrates a set of motion and impact sensors, such as accelerometers, gyroscopes, and vibration detectors, which are strategically placed within the vehicle to constantly monitor dynamic conditions, such as speed, orientation, and shock intensity [1, 2]. When an accident occurs, these sensors detect sudden changes in acceleration or sharp impacts, which are typically indicative of collision or rollover events. The data are immediately transmitted to a microcontroller, such as Arduino, ESP8266, or NodeMCU, which acts as the brain of the system, running embedded algorithms that assess whether the recorded changes exceed predefined threshold values set to indicate accident conditions [3, 4]. Upon confirming an accident scenario, the system activates the GPS module to obtain the exact geographic location of the vehicle. This data is then used by the GSM module to send SMS alerts containing the vehicle's coordinates and emergency status to predefined contacts, such as family members, police authorities, ambulance services, or traffic control centers [5, 6].

In addition to this basic setup, many recent advancements incorporate edge computing and real-time IoT cloud platforms that not only store data but also allow remote visualization and control through mobile apps or web dashboards, offering real-time access to live data for both emergency responders and fleet managers [7, 8]. For example, platforms such as Blynk or ThingSpeak can be used to log the vehicle's route, impact time, and speed before a collision. This information is useful for traffic analysis and accident forensics. Furthermore, some systems adopt On-Board Diagnostics (OBD-II) devices to fetch vehicle-specific diagnostic data, adding more granularity to the decision-making process [2]. A crucial enhancement introduced in recent studies is the integration of artificial intelligence (AI) and machine learning (ML) algorithms to improve detection accuracy and reduce false positives. AI models can be trained using historical sensor data and traffic scenarios to classify different types of accidents, detect near-miss situations, and prioritize the urgency of an incident based on severity analysis [9, 10].

Another noteworthy development is the incorporation of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication using VANET-based IoT technologies, which allows nearby vehicles and traffic control systems to be notified automatically in the event of an accident, enabling rapid traffic redirection and coordination [11]. This is particularly effective in reducing secondary accidents caused by sudden traffic stops. In urban smart city environments, such systems are envisioned to work with centralized cloud architectures that receive, store, and analyze large volumes of data from multiple connected vehicles to create real-time accident heat maps and predictive analytics dashboards [12]. Some frameworks also propose using camera modules and computer vision techniques to visually confirm accidents and stream videos or images to emergency centers [10], enabling responders to assess the scene before arriving. In conclusion, the IoT-based accident detection system represents a transformative shift in vehicular safety by combining sensing technologies, GPS tracking, wireless communication, AI-driven analytics, and smart infrastructure integration, resulting in a fully automated

and intelligent rescue mechanism that operates with minimal human intervention but maximum efficiency and responsiveness in critical moments, with an adverse effect on the firm-level stock return.

Circuit Diagram

Figure 1 illustrates the complete circuit configuration of the vehicle accident detection and rescue system. It shows the interconnection of the Arduino Uno with sensors and modules such as the accelerometer, alcohol sensor, GPS, GSM module, buzzer, and LCD, demonstrating how data is collected, processed, and used to trigger alerts during accident detection and emergencies.

RESULT ANALYSIS

The system accurately detects accidents using sensors, sends real-time location alerts, and enables faster emergency responses, thereby improving road safety.

Observation Table

The observation tables summarize the output obtained from the sensors used in this system. Table 1 presents the accelerometer readings and their corresponding detection results, highlighting the motion patterns and abnormal activities. Table 2 shows the alcohol sensor readings along with the alert status, indicating how the system responds when the alcohol levels exceed the predefined threshold.

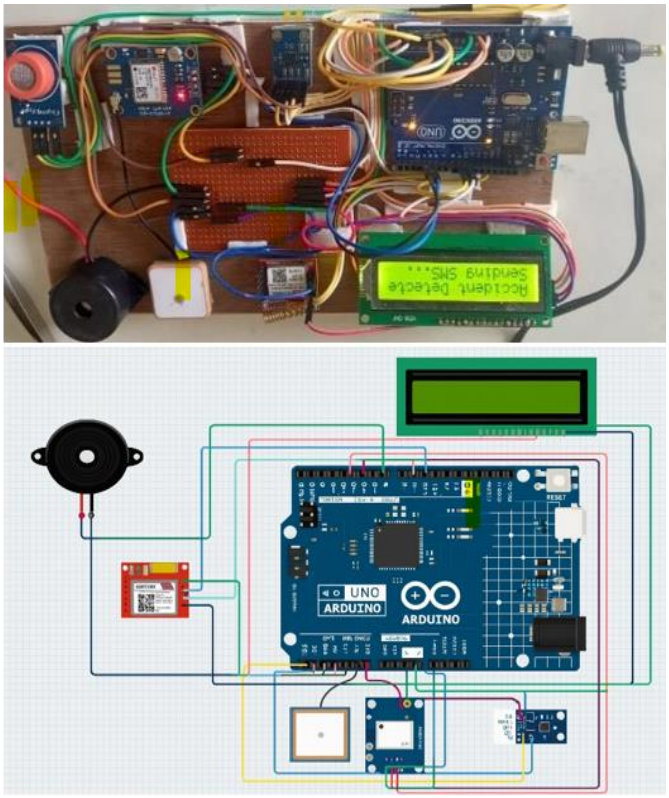

Figure 1. Construction of a vehicle accident detection and rescue system and circuit diagram.

Table 1. Accelerometer/detection.

S.N.	Sensor name	Parameter measured (g)	Normal value	Observed value	Accident detected (Y/N)	Location (GPS coordinates)	Alert sent (Y/N)
1	Accelerometer	Acceleration (g)	0–0.5 g	0.3 g	No	_	No
2	GPS	Latitude	N/A	N/A	_	22.34616.7	_
3	Accelerometer	Acceleration (g)	0–0.5 g	4.5 g	Yes	_	Yes
4	GPS	Longitude	N/A	N/A	_	88.463808	_

Table 2. Alcohol sensor/alert.

S.N.	Sensor name	Normal value (ppm)	Observed value (ppm)	Accident detected (Y/N)	Location (GPS coordinates)	Alert sent (Y/N)
1	Alcohol sensor	50	33	No	_	No
2	GPS latitude	22.34616.7	_	_	22.34616.7	_
3	GPS longitude	88.463808	_	_	88.463808	_
4	Alcohol sensor	50	120	Yes	_	Yes

Application

The application of an IoT-based vehicle accident detection and rescue system holds significant potential in enhancing road safety, minimizing emergency response time, and reducing fatalities caused by traffic accidents. This system is particularly valuable in both urban and remote areas where timely assistance can be challenging due to traffic congestion or a lack of nearby medical infrastructure. By automatically detecting accidents through real-time monitoring of vehicle dynamics, such as sudden deceleration, sharp tilts, or heavy impacts, the system eliminates the dependence on human intervention for reporting crashes. Once an accident is identified, it instantly communicates critical information including the precise GPS location, time of the event, and vehicle identification to emergency services, hospitals, and family members, thereby facilitating a faster and more coordinated rescue operation. This technology can be effectively deployed in private vehicles, commercial transport fleets, school buses, and public transportation systems to ensure driver and passenger safety. Moreover, its integration with mobile applications and cloud platforms allows for live monitoring, alert customization, and historical data storage, which can be used for post-accident analysis, insurance claims, and law enforcement investigations. In developing regions, where road conditions and emergency infrastructure may be inadequate, the system can play a transformative role in improving emergency outreach. Additionally, this system is instrumental for smart city initiatives, intelligent transportation systems, and autonomous vehicles, contributing to a broader ecosystem of connected mobility solutions aimed at preventing loss of life, promoting responsible driving, and enabling data-driven decisions in traffic management and public safety planning.

Future Scope

In the future, the system can integrate AI for better accuracy, connect with hospitals and traffic systems, and support vehicle-to-vehicle communications. Cloud-based data storage and real-time analytics can enhance decision-making, whereas mobile application integration can provide users with live updates and emergency assistance features for improved safety.

CONCLUSION

The IoT-based vehicle accident detection and rescue system has shown significant promise in enhancing road safety and minimizing the fatality risks associated with delayed emergency response. Through the integration of real-time monitoring, intelligent alert mechanisms, and robust communication technologies, the system bridges critical gaps in post-accident interventions.

The comprehensive result analysis indicates that such a system is not only technically feasible but also practically impactful when deployed at a large scale. Future enhancements can include integration with smart traffic systems, vehicle-to-infrastructure (V2I) communication, and AI-based accident prediction models to further extend the capabilities of this life-saving technology.

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